

# Evidence for Chemical Change

ATE

## Process Objectives

- To observe the types of evidence that indicate a chemical change has taken place.
- To infer from the observation of chemical change that a new substance has been formed.

## Learning Objectives

- To identify and record data that shows how heat is involved in chemical change.
- To explain why a substance can be either a reactant or a product in chemical reactions, and why this is necessary for recycling.

## Introduction

Substances may be created by chemical change and may also undergo chemical change. If a substance is produced as a result of a chemical change, or reaction, it is a product. If a substance is the subject of a chemical change, it is a reactant. The same substance can be either a reactant or a product, depending on the chemical reaction.

One way of knowing that a chemical change has occurred is by observing that the properties of the product are different from those of the beginning reactant. This new product can then become one of the reactants in another chemical reaction. In this experiment you will observe the sequence of changes that occur when a solution that begins as copper(II) nitrate is treated with a series of different reactants. All of the reactions will take place in the same test tube. Look for evidence that a new substance is formed from each chemical change. Also observe how heat and chemical reactions are related.

This chemical conversion of one product into another useful product is what we speak of as recycling. The copper(II) nitrate solution used in this experiment is prepared originally from the element copper and nitric acid. After a number of steps the copper is recovered.

Chemical changes are required to make these conversions. For example, the metals that are changed into alloys and shaped into soft-drink cans are themselves converted by chemical changes into other products. Recycling enables us to reuse scarce natural resources, such as copper and aluminum, usually at a lower cost than mining for them.



Take the necessary precautions before beginning this experiment. Wear safety goggles, apron, and gloves. Read all safety cautions in your procedures and discuss them with your teacher. It is important to use good safety techniques while conducting experiments. See pages 8 through 11.

## Apparatus

pyrex test tube 13 × 100 mm  
100 ml beaker  
burner and tubing  
ruler  
lab marker

stirring rod  
iron ring  
ring stand  
wire gauze, ceramic centered  
test tube rack

## Materials

1.0 M copper(II) nitrate  
1.5 M sodium hydroxide

1.5 M hydrochloric acid  
12 cm piece of aluminum wire

## Strategy for Inferring

Recall that a new substance is formed in a chemical change. Which of your observations indicate that a

substance is formed?

## Strategy for Observation

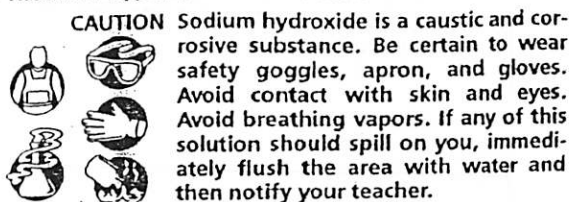
Use all of your senses (except taste) to observe changes that take place. Record all information about change.

## Record Your Observations

Where instructed in the procedures, record your observations in your Data Table.

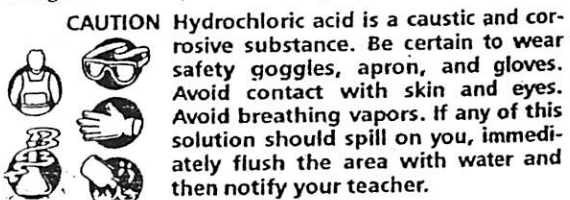
## Procedures

- In the 100 ml beaker, make a water bath by heating until boiling approximately 50 ml of water. This will be used in Step 5.
- While the water bath is heating make three marks that are 1 cm apart on a 13 × 100 mm test tube. Make the marks from the bottom up.
- Add 1.0 M copper(II) nitrate to the first mark on the test tube.



**CAUTION** Sodium hydroxide is a caustic and corrosive substance. Be certain to wear safety goggles, apron, and gloves. Avoid contact with skin and eyes. Avoid breathing vapors. If any of this solution should spill on you, immediately flush the area with water and then notify your teacher.

- Add 1.5 M sodium hydroxide to the second mark on the test tube. Mix with the stirring rod. Rinse the stirring rod. Touch the bottom of the outside of the test tube to see if heat has been released. The copper containing product is copper(II) hydroxide. The other product is sodium nitrate.
- Put the test tube in the water bath begun in Step 1. Heat it until no more change occurs. The products are copper(II) oxide and water.



**CAUTION** Hydrochloric acid is a caustic and corrosive substance. Be certain to wear safety goggles, apron, and gloves. Avoid contact with skin and eyes. Avoid breathing vapors. If any of this solution should spill on you, immediately flush the area with water and then notify your teacher.

- Remove the test tube from the hot water bath. Turn off the burner. Cool the test tube and its contents for 2 minutes in room temperature water. Add 1.5 M hydrochloric acid to the third mark. Mix with the stirring rod. Rinse the stirring rod. The products are copper(II) chloride and water.
- Place a 10 cm piece of aluminum wire in the test tube. Leave it until no more reaction is observed. Touch the bottom of the test tube to check for temperature change. Two reactions take place. Copper(II) chloride and aluminum produce copper and aluminum chloride. The aluminum also reacts with the hydrochloric acid to form hydrogen and aluminum chloride.
- Remove the wire from the test tube. Compare the copper formed to a sample of copper wire.
- Dispose of the solids and the liquids formed in the experiment as your teacher directs. Empty the water from the hot water bath. Clean all equipment used. Remember to wash your hands before you leave the laboratory.

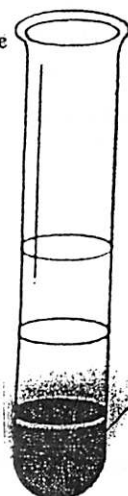


Figure 2-1

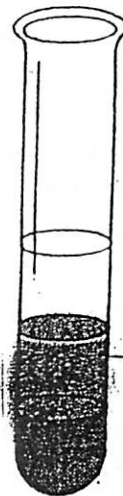


Figure 2-2

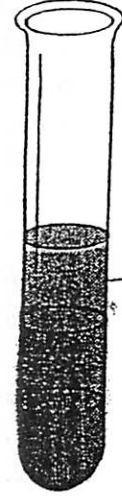


Figure 2-3

Sample Data Table			
Reactants	Products	Observations of Products	
		Precipitate (Solid)	Supernate (Liquid)
Copper(II) nitrate (blue solution) + Sodium hydroxide (colorless solution)	+		
Copper(II) hydroxide  + (heat)	+		
Copper(II) oxide  + Hydrochloric acid	+		
Aluminum  + Copper(II) chloride	+		
Aluminum  + Hydrochloric acid	+		

### Questions

1. What are some causes of chemical changes?
2. In what two ways is heat involved in chemical change? Cite specific instances from the experiment.
3. Identify the substances that are used or produced in this experiment. Distinguish between elements and compounds.
4. In the last step of the experiment, where is the aluminum chloride? How could you recover it?
5. What is the color of solutions of copper compounds?
6. What are some of the substances used in this experiment that dissolve in water? Which do not?
7. In your notebook, complete the following word equations by referring to the procedures in the experiment.
  - (a) Copper(II) nitrate + sodium hydroxide = ?
  - (b) Copper(II) hydroxide + heat = ?
  - (c) Copper(II) oxide + hydrochloric acid = ?
  - (d) Copper(II) chloride + aluminum = ?
  - (e) Hydrochloric acid + aluminum = ?

### General Conclusions

1. List four types of observations that indicate when a chemical change has occurred.
2. Describe the advantages and disadvantages of recycling metals as was done in this experiment.

Indicate  
all questions  
in a separate  
sheet